1920
T23

L. R. Tehon

Two Sooty Molds Occurring on the Mango in Porto Rico

TWO SOOTY MOLDS OCCURRING ON THE MANGO IN PORTO RICO

BY

LEO ROY TEHON
A. B. University of Wyoming
1916

THESIS

Submitted in Partial Fulfillment

of the requirements for the

Degree of

MASTER OF ARTS

IN BOTANY

IN

THE GRADUATE SCHOOL
OF THE
UNIVERSITY OF ILLINOIS

1920

1920
T23

UNIVERSITY OF ILLINOIS

THE GRADUATE SCHOOL

June 2 1920

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY L. R. Tehon.

ENTITLED Two Sooty Molds Occurring on the Mango in Porto Rico.

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF Master of Arts

F. L. Stevens
In Charge of Thesis

Wm. Trelease.
Head of Department

Recommendation concurred in*

Committee
on
Final Examination*

---

*Required for doctor's degree but not for master's

455080

THE RARE BOOK & MANUSCRIPT LIBRARY
UIUC

TABLE OF CONTENTS.

Digitized by the Internet Archive
in 2014

http://archive.org/details/twosootymoldsocc00teho

TWO SOOTY MOLDS OCCURRING ON THE MANGO IN PORTO RICO

BY

Leo R. Tehon

-o-O-o-

I. Introduction.

The present study has arisen from an interest which the writer has had for some time in the group of fungi known commonly as sooty molds. According to the accepted conception, they belong chiefly to the Capnodiaceae. Their variety of mycelial, perithecial, pycnidial and conidial characters has rendered them a difficult and a poorly understood group.

The greatest difficulty in studying these fungi lies in the impossibility of correctly interpreting connections between pycnidial or conidial forms and their perfect or perithecial forms. Probably the only means of obviating this difficulty is in isolating, in pure culture, the sooty mold fungus and following its development either on artificial media or on the leaves of its host plant.

With this in mind the writer undertook to attempt the artificial culture of sooty molds, and to carry on observations of their morphology and development as far as possible in the time

available. Accordingly, a quantity of Mango leaves bearing sooty molds were secured from Porto Rico, together with some young Mango plants. The Mango plants have had a vicarious existence in the greenhouse, but have not developed sooty molds except as artificially inoculated.

The mold bearing leaves, on microscopical examination, showed the presence of a typical capnodiaceous mold characterized by toruloid portions of the mycelium, pycnidia of the Chaetophoma type, conidia of the Helminthosporium and torula types, and the usual perithecia containing evidently immature, hyaline ascospores. There were also present the common seuratoid structures, varying from small spheric groups of cells to large masses such as shown in Plate 1, fig ure 1.

II. Isolation.

Immediately upon receipt of the living sooty mold material from Porto Rico, attempts were begun to secure growth on artificial media. Several kinds of media were used, including 10% agar, corn-meal agar, potato agar, washed agar, and agar to which 1% cane sugar was added.

The character of a sooty mold is such that it is not easily broken up so as to be suitable for the usual poured-plate method of isolation. Consequently, small and large flakes of sooty mold were placed directly on the surface of previously prepared petri dishes. These were then placed in an incubator at 32° C., in the hope that a temperature somewhat higher than room temperature would stimulate growth. The presence of a very great number of bacterial and fungal saprophytes indicated immediately that this method of isolation could not be used because the saprophytes made

immediate and active growth, either preventing or far out-stripping the growth of the sooty mold.

A second method employed, consisted only in crushing a flake of the mold in water, adding this suspension to tubes of media, and continuing the process of dilution plating. This served however, only to scatter the undesired organisms more thoroly thru the medium; and their rapid growth brought results similar to those of the first method. Attempted partial sterilization of sooty mold flakes to eliminate the rapidly growing saprophytes did not give satisfactory results, the sooty mold evidently succumbing to the treatment quite as readily as the other organisms.

In the meantime, those plates, containing cane sugar agar, which had been first used began to show areas of dark growth emanating from the patches of sooty mold used as an inoculum. These areas were not extensive, but showed a mycelium similar to the sooty mold mycelium particularly in the assumption, at intervals near the outer limit of growth, of a typically toruloid habit. Attempts to isolate this growth from the plates in which it appeared were unsuccessful because of the abundance of Alternaria spores and mycelium.

The plan was eventually hit upon of crushing a considerable amount of sooty mold very thoroly in company with a large amount of fine sterilized sand in a mortar. This process had the obvious advantages of breaking the sooty mold into minute parts, and of scattering both sooty-mold and other organisms uniformly thruout a considerable quantity of gross material. In poured plates this resulted in a satisfactory separation of mold and saprophytes. Upon the appearance of bacterial colonies, and of Alternaria

colonies, they could be immediately removed, and the plates thus kept free of organisms having a tendency to over-run the sooty molds.

In the course of a week, colonies of dark mycelium began to make their appearance in the petri-dishes, particularly in those containing the 1% cane-sugar agar; and in the course of two weeks typical toruloid mycelium made its appearance. These colonies were of two types, described and referred to later under the names of Capnodium and Seuratia. After the appearance of toruloid mycelium the two fungi were planted in pure culture in tubes of 1% cane sugar agar.

III. Host Inoculation.

Leaves were then selected on the Mango plants in the green house, and the fungi transplated from tubes to the leaves. On these leaves, patches of black fungous growth appeared, as shown in Plate 3, figure 1. The patches were entirely superficial and typical, both in gross and microscopic appearance, of the young colonies developed on leaves naturally. No growth appeared on uninoculated leaves.

In connection with the growth of sooty molds, both in tropical and temperate climates, the belief is prevalent that honey dew, secreted by sucking insects parasitic upon plants, furnishes the substratum from which sooty molds secure their foods. That honey dew may furnish such a substratum and so be of great influence in the development and spread of sooty molds can easily be established by the observation of plants actively parasitized by sucking insects. In the tropics sooty molds are, however, much more abundant than would be expected were they entirely dependent

on honey dew. A possible explanation of their growth in the absence of insect secreted materials became apparent in the inoculation work.

The plants used as hosts were covered for a time, after being inoculated, with bell jars in order to provide a humid atmosphere for development. The soil had been saturated, and guttation resulted in the case of the young leaves, small drops of moisture appearing on their upper surfaces. On the removal of the bell jars, these drops partially evaporated leaving small spots of sticky substance on the surface of the leaves. Such a process of alternate guttation and drying might closely paralell conditions as they exist in the tropics, and the presence of a sugar-containing exudate on the leaves would undoubtedly aid in the development of the sooty molds. This possibility seems especially likely in view of the exceedingly common occurrence of sooty molds in the tropics. No experimental work was carried out in this connection, the observation being merely included as a sugestion. It is at least certain that the leaves used for inoculation purposes, and on which sooty mold did develop, were not supplied with honey dew.

IV. Rate of Growth.

In the petri-dish cultures, as well as on the host artificially inoculated, one point is especially remarkable, namely that the sooty mold is slow growing. In the original plate cultures, other organisms grew much more rapidly than the mold, and the growth shown on the host leaf in Plate 3, figure 1, was attained only after six weeks under green house conditions. This fact corresponds closely with observations made by botanists in the tropics, where young leaves, or those in the process of develop-

ment, are rarely if ever seen completely over-grown, while those leaves which are completely over-grown with mold are full-sized, mature, and quite frequently have already fallen to the ground.

The two fungi isolated were strikingly different. One was typical in its mycelial characters of a Capnodium and will be refered to under that name. The other showed characteristics which have lead the writer to refer it to Seuratia, another genus of the Capnodiaceae.

V. Capnodium.

The name Capnodium is employed merely as a matter of convenience. It is the custom to refer sooty molds to one or another of the Capnodiaceous genera whether or not asci and ascospores have been observed. The chaotic species differentiation is such that the specific name frequently serves merely to indicate the host occupied.

In the original specimens, this fungus showed a mycelium differentiated into two sorts. Forming the greater part of the mold was a regular mycelium, straight, black, septate, slightly or not at all constricted, and irregularly branching. Irregularly distributed patches of the other type of mycelium, apparently connected with the first, showed a toruloid condition, the cells being of larger diameter, definitely const icted at the septa, and becoming at times almost spheric.

Small pycnidia, either conic or spheric, were abundant. Observation showed three general types of pycnidial development. In one instance, development proceeded from the septation of a single cell which might be located at any point in the mycelium.

It is illustrated in figures 1, 2 and 3 of plate 1. The second method proceeded, as shown in figures 4 and 5 of plate 1, from a group of cells of the same or neighboring hyphae. The third method is the formation of a pycnidium from the tip of an hypha. Here a number of cells (plate 1, fig.6) apparently arise from the final cell of the hypha, and each of these cells give rise, in turn, to short hyphae (plate 1, fig. 7), which eventually coalesce, probably by intercalary growth, into a pycnidium. This last case has an appearance very similar in its earlier stages to a coremium. Pycnidiospores, irrespesctive of the type of pycnidium, are hyaline, round, to ellipsoid, and average about 3µ in length.

Cultures: The Capnodium has grown well, after isolation, on the 1% cane sugar agar medium. Growth proceeds radially and symmetrically from the original point, but very slowly whether at room temperature or at 32° C. The hyphae are dark, straight, rarely constricted, almost hyaline at their tips, and seldom send up conidiophores. When conidiophores are produced they are long and bear usually from one to three spores of a sort similar to those of Helminthosporium (plate 2, fig. 5). Torulae, or a toruloid mycelium, is not produced so long as active growth is maintained.

Variations of the sugar content of the medium (1, 2, 3, 5, 10, 20, 40 and 50%) bring about evident effects. Concentrations up to 3% do not cause any remarkable changes, the character of growth being about the same up to this point. A concentration of 5% results in a slower growth and the formation of occasional toruloid areas. At 10%, toruloid formation is more vigorous, and the growth of the colony is less rapid. At 20, 40 and 50%, little or no growth appears.

The effect of moisture variations is striking, both with respect to relative amounts, and to alternate periods of dry and moist conditions. Variation of the amount of water available was easily accomplished in cultures by varying the percentage of agar used in making the canē-sugar medium. Three per cent agar, which attains only a relative solidity at room temperature, and which is practically liquid at 32° C., gave little growth; 5% agar which is solid at room temperature, gave a vigorous growth, as did also 10% agar. Growth above these concentrations becomes steadily less and is coupled with a more frequent and abundant formation of toruloid mycelium. The heavy masses of toruloid mycelium can be seen in plate 4, figure 3, near the outer limits of the primary growth. Helminthosporium production occurs on the lesser concentrations, but diminishes at the concentration is increased.

A particularly humid atmosphere within the petri dish , secured by covering the dish immediately after pouring, results in a copious production of aerial mycelium. This aerial mycelium consists largely of the sporophores of Helminthosporium. The spores produced are, however, much more numerous, and the sporophores longer, than is the case under less humid conditions. The production of the aerial mycelium can, on the other hand, be almost entirely prevented by providing a free circulation of dry air in and out of the petri-dish.

Alternate dry and moist periods serve to increase the formation of toruloid mycelium (plate 4, fig. 3); and the exhaustion of the water supply tends to bring about the formation of symphyogenous masses (plate 4, fig.3) in the center and near the periphery of the colony. These symphyogenous masses are made up of a toruloid mycelium, and resemble young perithecia in the mode of their

development. Time has not, however, permitted their full develop- in the laboratory cultures.

On the washed agar medium, very little growth could be secured; on the 10% agar medium, the growth is still small, and nearly hyaline. But on agar to which 1 to 3% of cane sugar has been added, growth is vigorous, and the color is dark. On corn meal agar, the colony never develops very far, and assumes a decided greenish tinge. Potato agar and soluble starch agar, both give some growth; but it is not vigorous, and the color is variable being in spots nearly hyaline and in others rather blackish.

VI. Seuratia.

Among the large number of sooty molds the writer has examined, the Seuratiae hold a pre-eminent interest because of their unusual morphology and because of the various interpretations they have received. Seuratization is a condition characterized by a swelling and gelatinization of cell walls together with a frequent failure to form the usual well-defined mycelial strands, -- a condition often resulting in striking fungal monstrosities (see Plate I, fig. 3). Typical examples are to be found in Seuratia coffeicola Pat. and in Capnodium stellatum Ch. Bernard. These fungi were first studied by Patouillard who described in 1904 (5) a single species, and established for it the genus Seuratia. The genus was characterized by him as having no subiculum, the perithecium being gelatinous walled in the presence of moisture, variously branched, and made up of sub-hyaline moniliform hyphae. It was separated from the other genera of the Capnodiaceae by the absence of a superficial mycelium, by its gelatinous consistency, and by its 2-celled hyaline spores.

Vuillemin described a second species (S. pinicola) in 1905 (7) with which as a basis he proposed a new family, the Seuratiaceae. Bernard (3) in working with Capnodium stellatum in 1907, noted the presence of seuratoid structures believing them to be the conceptacles of a fungus different from the Capnodium. Vuillemin (6) considers that Bernard's Capnodium stellatum is made up of two fungi, a Capnodium and a Seuratia. He expresses the opinion that the association of the two results in morphological consequences "comparable to those of algo-fungal association."

Arnaud (1) endeavors to prove, by microscopical examination, that seuratoid structures occurring in connection Plaeosphaeria citri (Capnodium citri Penzig) represent gelatinous modifications of the normal fruiting structures of that fungus. He also suggests (2) that seuratoid structures are gelatinous modifications common to the sooty mold group, and that such modifications obtain both in reproductive structures and in mycelium. His contentions are up-held, in part, by his having found dark muriform spores in connection with seuratia.

It is to be noted that all the foregoing is based merely on microscopical examination of material collected for herbarium purposes. There is no disagreement as regards the phyletic position of the Seuratiae, except in so far as Arnaud believes them to be, in company with many other of the Capnodiaceae, allied with certain genera of the Sphaeriaceae.

In the material received from Porto Rico, the writer has found seuratoid structures to be exceedingly variable in size and appearance. The size varies from only a few cells to masses as much as two or three millimeters in diameter. In shape they are, when simplest, spheric aggregations of a few cells; but in more

complex forms they are thick and exceedingly irregular in outline. Figure 3 of Plate I illustrates a typical example of the latter. In either case, these cell agglomerations may send out straight or toruloid hyphae which serve as connections between adjacent seuratia.

When in a dry condition on their host they appear as black crusty masses. In the presence of moisture, which they absorb very readily, they expand rapidly and assume a gelatinous consistency. Under the microscope, their surface in this expanded condition appears to be dotted with dark brown spots, each spot being surrounded by a wide halo of a much lighter color (Plate I, fig. 2).

Whether crushed, or carefully sectioned, their internal structure appears the same. Towards the periphery, the seuratia are made up of characteristically toruloid hyphae. In the interior of the seuratoid body, hyphal structure is not so evident. The cells here are strikingly levuriform. Evident connection between cells is maintained, however, by long, narrow isthmi which reach through the thick walls of the connected cells. Among these internal cells, there is no uniformity of size. The general oval shape appears variously distorted according to the size and the number of the connecting isthmi.

There is always present in quantity small (1.5x 3μ), oval, hyaline conidia similar in appearance to those produced by pycnidia of the Chaetophoma type. Spores varying from two-celled and hyaline, to muriform and dark (Plate I, fig. 1) occasionally occur in connection with the larger seuratia; but the writer has never found them in asci.

<u>Cultures</u>: After isolation, observations made on petri-dish cultures revealed interesting facts in regard to the growth

and development of the Mango seuratia. A colony may, of course, start either from one, or from more than one cell. In either case, development is practically the same. In its gross aspect, a small white or hyaline spot appears near the surface of the medium. This spot slowly enlarges its circumference, and one may see extending through it in radial fashion a few well-defined strands of mycelium. These strands make up only a small portion of the colony. The remainder of the colony has the appearance, because of the production of large numbers of micro-conidia, of a colony of large bacteria.

Microscopical examination during the early growth of the colony reveals the condition shown in Plate II, figure 2a, where a single cell has begun growth by sending out a short filament. At the same time, this filament has produced a number of small micro-conidia.

Continued growth of the colony is represented in the growth and branching of the original filaments together with a more than copious production of micro-conidia. The filaments give to the colony its mycelial appearance, and the large mass of micro-conidia its bacterial aspect.

As the colony grows, it takes on a darker hue, and eventually becomes black. Its central portion becomes a moist black mass of fungal cells with a few toruloid hyphae extending beyond as shown in Plate II, figure 9. When this condition is reached, the toruloid hyphae appear as shown in Plate II, figure 1.

From this point on,-growth is more rapid, and concerns the external toruloid hyphae much more than the central mass of cells. The growth of the external hyphae now takes on an irregular character. Certain of the shorter ones retain their toruloid habit, and

continue to produce an abundance of micro-conidia (Plate II, figure 8). The remaining hyphae begin a process of more rapid elongation thru the production of straight, unconstricted cells which alternate at intervals with short groups of toruloid cells (Plate II, figure 3). These rapidly elongating hyphae are not prolific producers of micr-conidia.

With the gradual extension of the colony, the black central mass of cells slowly augments istelf. Its foundation was, of course, laid by the initial filaments, and the micro-conidia which they produced. The micro-conidia themselves are of peculiar interest because of the changes they undergo. Their production by filaments is very similar(Plate II, figures 8 and 8a) to the budding process of yeasts. Once free from their parent filament, they still retain the power of growth and become at length large cells surrounded by a thick gelatinous wall (Plate II, figure16). At maturity they become dark in color, and give to the central cell mass both its size and its black, shiny appearance. When originally formed, they are not capable of germination; but when large and mature their germination results in the formation of remarkable levuriform filaments of varied lengths as shown in Plate II, figures 11, 14 and 15.

External filaments, while having an unlimited power of growth and extension, go through evident morphological changes of an interesting nature. As a rule, the stretches of toruloid cells developed do not remain merely as toruloid portions of a filament. Starting with a toruloid section, such as shown in Plate II, figure 4, a complex mass of spheric cells arise which in their ultimate form are in all respects similar to the mass of cells at the center of the colony. This production of a secondary mass of cells results from the germination of the toruloid cells, and from the pro-

duction of micro-conidia as shown in Plate II, figure 7. The nearness of the other hyphae of the colony evidently act as an inhibiting influence, so that the gemination of the toruloid elements does not result in filament production, but only in the production of more toruloid cells. These and the matured micro-conidia, by a process of continued cell division and growth, are eventually responsible for the formation of secondary cell masses irregularly scattered throughout the periphery of the colony, but in every respect similar to the cell mass at the center.

The production of an aerial mycelium is not common in culture. If a saturated atmosphere be maintained in the petri-dish, aerial growth may be stimulated to a certain degree. Such an aerial growth is, however, never abundant, and is confined to the production of conidiophores and conidia of the type Torula as shown in Plate II, figure 10.

The observations recorded above were made with the Seuratia growing on 1% cane-sugar agar. Various concentrations of sugar in the medium bring about changes in growth which have to do chiefly with its rapidity. On washed agar, and on agar to which no cane-sugar was added, growth was exceedingly slow and definitely limited, the colonies seldom attaining a millimeter in diameter. With the addition of 1, 2 and 3% cane-sugar, growth is vigorous and unlimited. With 5% cane sugar, growth is weaker, and becomes steadily more feeble on 10, 20, 40 and 50%. In cases of feeble growth the external filaments are not actively produced, the colony being limited to the production of the central mass of cells, and a small fringe of toruloid hyphae.

Variations of the quantity of moisture available make themselves evident in two ways. If there is very little moisture,

available, the colony usually develops no farther than thru the production of the central mass of cells and a few long toruloid hyphae which in turn develop a number of small cell masses along their course (see Plate V, fig. 1). With an increase in moisture, hyphae external to the central mass are produced in abundance, and the number of toruloid sections are relatively much fewer, and separated by greater distances. The growth is more rapid, and the production of micro-conidia is likewise stimulated. The presence of abundant moisture, is a necessary element in the production of an aerial mycelium. The aerial mycelium, however, is confined to the production of conidia referable to the genus Torula (Plate II, fig. 10).

As a matter of interest connected with the apparent necessity of a carbohydrate as a nutrient material, a number of sugars were substituted in the place of cane sugar. The results are summarized briefly:

Monosaccharides:

Galactose: Growth slight, filamentous, dense, not widespread. Terminal growth hyaline to white; older growth dense black. Mycelium deep in the medium. Colony not remarkably radiate or zonate.

Dextrose (C.P. by alcohol): Growth abundant, of coarse and fine radiating hyphae. Color greenish to black. Cell-masses numerous not uniform in size, and near the center of the colony. The colony definitely striated and zonated.

Levulose: Similar to dextrose except that the filaments become a little coarser, and the cell masses are generally smaller and less numerous.

Disaccharides:

Saccharose: Growth active but not extensive, large quantities of cell masses having a particularly moist and shiny appearance. Filaments dense and coarse, and black thruout. The colony neither zonate or striate.

Lactose: Growth fairly active, and characterized by the production of large fan-shaped feathery sectors below the surface of the medium. Color grayish to black. Cell masses few. No zonation or striation.

Maltose: Rich growth, chiefly filamentous. Cell masses few, irregularly placed, and large. Filaments radiate and heavy. Colony olive brown; zonations and striations markedly apparent. See Plate IV, fig. 1.

Polysaccharides:

Soluble starch: Growth slight, chiefly filamentous with occasional formation of cell masses. Terminal growth white; older growth greenish. Slightly striated and radiate. See Plate IV, fig. 2.

Raffinose: Growth abundant, of long delicate filamentous strands, brownish, varying to gray. Regularly striated. Small cell masses scattered thru the center of the colony. Somewhat radiate.

Pentose:

Rhamnose: Growth active, regularly but not sharply striate Filaments fine for the most part, alternating with occasional coarser ones. The center of the colony a massive cell mass. Radiations pronounced.

Control:

Washed Agar: Growth slight, grayish, neither radiate nor

striate. Filaments coarse and feathery. No external or secondary formation of cell masses.

From the foregoing it may readily be seen that certain sugars bring about definite modification of the colonies, particularly with reference to color, vigor of growth, radiation, striation, and the production of cell masses. There is, however, no evident preference manifest for any one of the various groups of sugars tried.

Rate of Growth: The length of time required for growth in Seuratia is greater even than that required for Capnodium. At the end of a week, inoculated plates show only small (1 mm.) white or hyaline colonies. At the end of two weeks, the colonies have doubled their diameter, the central mass has become black, and a scant fringe of toruloid hyphae have developed. In most cases, four to six weeks are required for a colony to cover the medium in a petri-dish, -- a fact in strong contrast with the rapid growth of Alternaria where a petri-dish may be covered in seven days or less.

An interesting observation is the fact that, in petri-dishes set away on shelves and allowed to dry out, cultures made from the central cell masses have proved the viability of this particular part of the culture after a period of three months.

VII. Interaction of Capnodium and Seuratia in Culture.

Arnaud's contention (1,2) that seuratia are merely morphological modifications of Capnodiaceous fruiting bodies and mycelium together with Vuillemin's (6) belief that two fungi are present, led the writer to plant both the Capnodium and the Seuratia a number

of times in the same petri-dish. This direct comparison indicated first of all that of the two, the Seuratia grew much more slowly. When the two colonies began to approach each other, the Capnodium exhibited a marked inhibitory influence on the growth of the Seuratia. The Seuratia did not, however, exhibit a similar, equally well defined influence on the Capnodium. Eventually, the hyphae of the Capnodium penetrated into the Seuratia colony and become indistinguishable from the hyphae of the Seuratia. The Seuratia, while succumbing to the influence of the Capnodium, did not form a barrier to the growth of the Capnodium,--a condition which will easily explain how the two may be so closely interwoven on the host leaf as to be indistinguishable even with careful attention.

VIII. An Interpretation of Seuratia.

The question of the function and significance of seuratoid bodies is one which has not been satisfactorily explained. The finding of hyaline and of dark muriform spores has led to the belief that they represent modified ascocarps. While it is entirely possible that they may eventually serve as such, Arnaud's interpretation of them as gelatinous modifications of ordinary sooty mold mycelium partially opposes this view.

The present cultural studies indicate that seuratia have at least another function. Cells from the seuratia, germinated in a hanging drop of cane sugar solution (Plate II, fig. 12) indicate their ability to act as spores. Their further germination and development in the cell masses of the colonies with the formation of irregularly formed filaments (Plate II, figures 6, 11, 14 and 15) together with the manner of germination (Plate II, fig. 6) indicates something of a chlamydic nature.

The development of toruloid sections in the mycelial filaments of the cultures, extraneous to the central cell masses, is at once suggestive of the possibility that these toruloid cells are actually chlamydospores. Their germination and growth into secondary cell masses, the cells of which are large, spherical, heavy-walled, gelatinous, and capable singly of germination, also points to their spore nature.

The writer believes, therefore, that Seuratia are to be regarded, not as gelatinous modifications of normal mycelium, but as agglomerations of gelatinous-walled chlamydospores, to which the term "chlamydo-complexes" can very appropriately be applied.

IX. Summary.

The results of the writer's study of the sooty mold of the Mango, while not as complete as could be wished, may be summarized as follows:

It is possible to grow the sooty mold,which was present on the Mango leaves imported from Porto Rico, in artificial culture on artificial media. This sooty mold is made up of two fungi, one belonging to the genus Capnodium, and the other to the genus Seuratia. Both are slow-growing, whether in culture or on the host plant. It is probable that some form of carbohydrate is necessary for the active growth. This carbohydrate may be supplied by sucking insects in the form of honey dew, but the suggestion is made that periods of alternate guttation and evaporation which closely parallel normal tropical conditions might serve the same purpose.

Seuratia is not, in this case, a gelatinous modification of the Capnodium, but a separate fungus with a characteristic seura-

toid habit. Seuratoid bodies are to be regarded rather as gelatinous chlamydo-complexes, than as common modifications of Capnodiaceous mycelia or conceptacles.

The Seuratia does not exhibit in culture any preference for mono-, di, or polysaccharides, or for pentoses, though given sugars exert marked influences on mycelial and colony characters.

BIBLIOGRAPHY

1. Arnaud, Gabriel. Contribution à l'étude des fumagines. Annales de l'École Nationale d'Agriculture de Montpellier. 9: 239-277. 1910

2. ------, ------- Contricution à l'étude des fumagines. Annales de l'École Nationale d'Agriculture de Montpellier. 10: 211-330. 1911

3. Bernard, Ch. Sur quelques maladies de Citrus sp. A. Sur la fumagine de divers végétaux. Bulletin du Department de l'Agriculture des Indes Neerlandais. No. 11: 1-24. 1907.

4. Patouillard, N. Champignons recueillis par M. Seurat dans la Polynésie Francaise. Bul. Soc. Myc. de France. 22.1er fasc.

5. -----------, - Description de quelques champignons noveaux des iles Gambier. Bul. Soc. Myc. de France. 20: 135-138. 1904.

6. Vuillemin, P. Le genre Seuratia et ses connexions avec les Capnodium. Comptes rondes de l'Académie de sciences de Paris. 144: 307-308. 1908.

7. ---------, -. Seuratia pinicola sp. nov. Type d'une nouvelle famille d'ascomycètes. Bul. Soc. Myc. de France. 21: 77 (Plate IV). 1905.

Related literature not bearing directly on points discussed in this paper:

1. Maire, R. Contricution à l'étude de la flore mycologique de l'Afrique de Nord. Bul. Soc. Bot. de France. 54: cxxiii. 1907.

2. Patouillard, N. Fragments mycologiques. Journal de Botanique. 3: 259. 1889.

3. Planchon, I. Influence de divers milieux chimiques sur quelques champignons du groupe des Dématiées. Annales des Sci. Nat. Bot. VIIIe Serie, 76 annié. No. 1,2,3,4. 1900.

4. Roze, ------ Contricution à l'étude de la fumagine. Bul. Soc. Bot. de France. 14: 15. 1867.

5. Zopf, W. Die conidien früchte von Fumago. Nova Acta Leop. Carol. Deutsch. Akad. 40: 1878.

Explanation Of Plates.

Plate I.

Upper Panel: Outline drawing of a typical seuratoid body.

1. A muriform spore such as is occasionally found.

2. Hyphae from the periphery of the seuratoid body after abosorbing moisture.

3. A seuratoid body, on of the fungous monstrosities resulting from the curious manner of growth obtaining among the Seuratiae.

Lower Panel: Pycnidial formation of Capnodium.

1, 2, 3. From a single hyphal cell.

4,5. From several hyphal cells or from several hyphae.

6,7. From a terminal hyphal cell.

Plate II.

Fig. 1. A toruloid hypha from a young colony of Seuratia.

2. Germination of a toruloid cell with production of microconidia.

3. Alternation of Torulae and straight cells in seuratoid hyphae.

4. A small group of toruloid hyphae, the basis of a secondary chlamydo-complex.

6. Germination of a cell of the chlamydo-complex. Note heavy wall of the spore cell, and narrow connecting isthmus.

5. Helminthosporium-like spore of Capnodium.

7. An early stage in the production of a secondary Chlamydo-complex.

8. A typical toruloid filament with numerous microconidia.

9. A young colony of Seuratia, x 100, showing chlamydo-complex and radiating toruloid hyphae.

10. Aerial Torulae produced by Seuratia under moist conditions.

Plate II (Cont'd)

11. A short filament from the interior of the chlamydo-complex of a young culture.

12. Germination of toruloid cells in a hanging drop of cane sugar solution.

13. Further stage in the development of a secondary chlamydo-complex.

14, 15. Portions of filaments from the interior of older chlamydo-complexes. In each case the original cell is still evident, and apparently an organic part of the filament.

16. Cells from the interior of a very young chlamydo-complex. These are the cells which, after a period of enlargement, act as spores in producing filaments such as shown in fig. 14 and 15.

Plate III.

Portion of the leaf of Mango showing sooty mold produced by artificial inoculation with Seuratia. Magnified x 2.

Plate IV.

Fig. 1. Seuratia on Maltose agar, showing rich filamentous growth with radiations and striations.

2. Seuratia on Soluble Starch agar, showing formation of chlamydo-complexes in the periphery of the colony.

3. Capnodium on cane-sugar agar. Note the evident toruloid areas near the border of the primary growth, and the numerous symphcogenous masses in the secondary growth.

4. Seuratia on cane-sugar agar. Moisture not abundant.

Plate V.

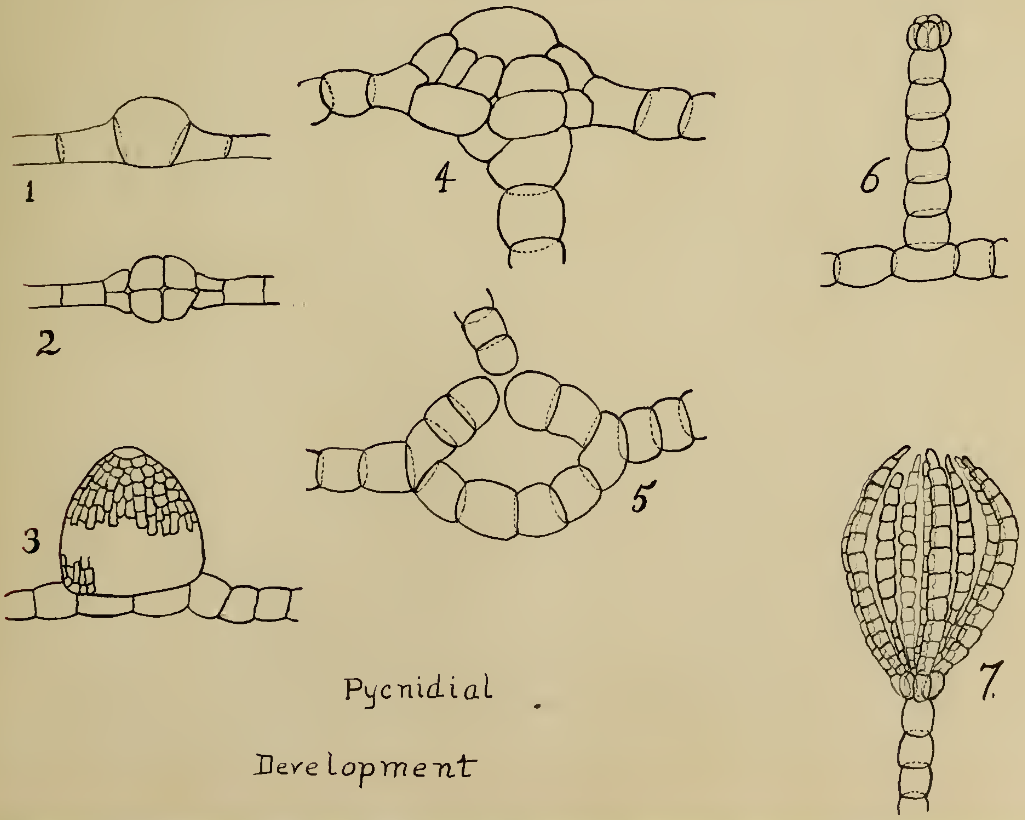
Fig. 1. Seuratia on cane-sugar agar. Moisture supply very limited.

2. On cane-sugar agar. Moisture abundant.

3. On washed agar. Thickly planted to show character of growth.

4. On corn meal agar. Light colored with numerous chlamydo-complexes.

A typical large seuratoid body.



Pycnidial Development

PLATE I.

THE LIBRARY
OF THE
UNIVERSITY OF ILLINOIS

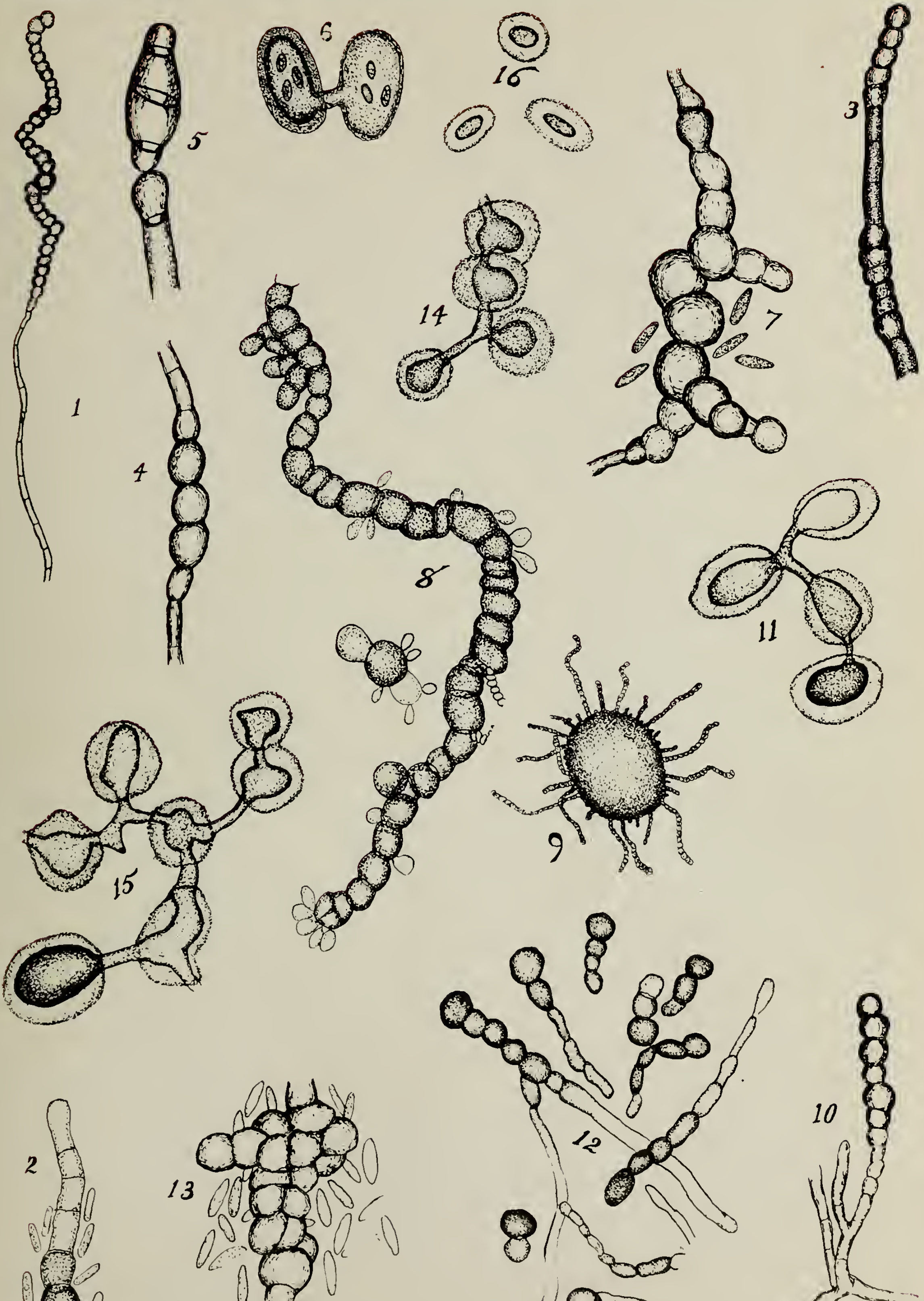


PLATE II

THE LIBRARY
OF THE
UNIVERSITY OF ILLINOIS

PLATE III.

THE LIBRARY
OF THE
UNIVERSITY OF ILLINOIS

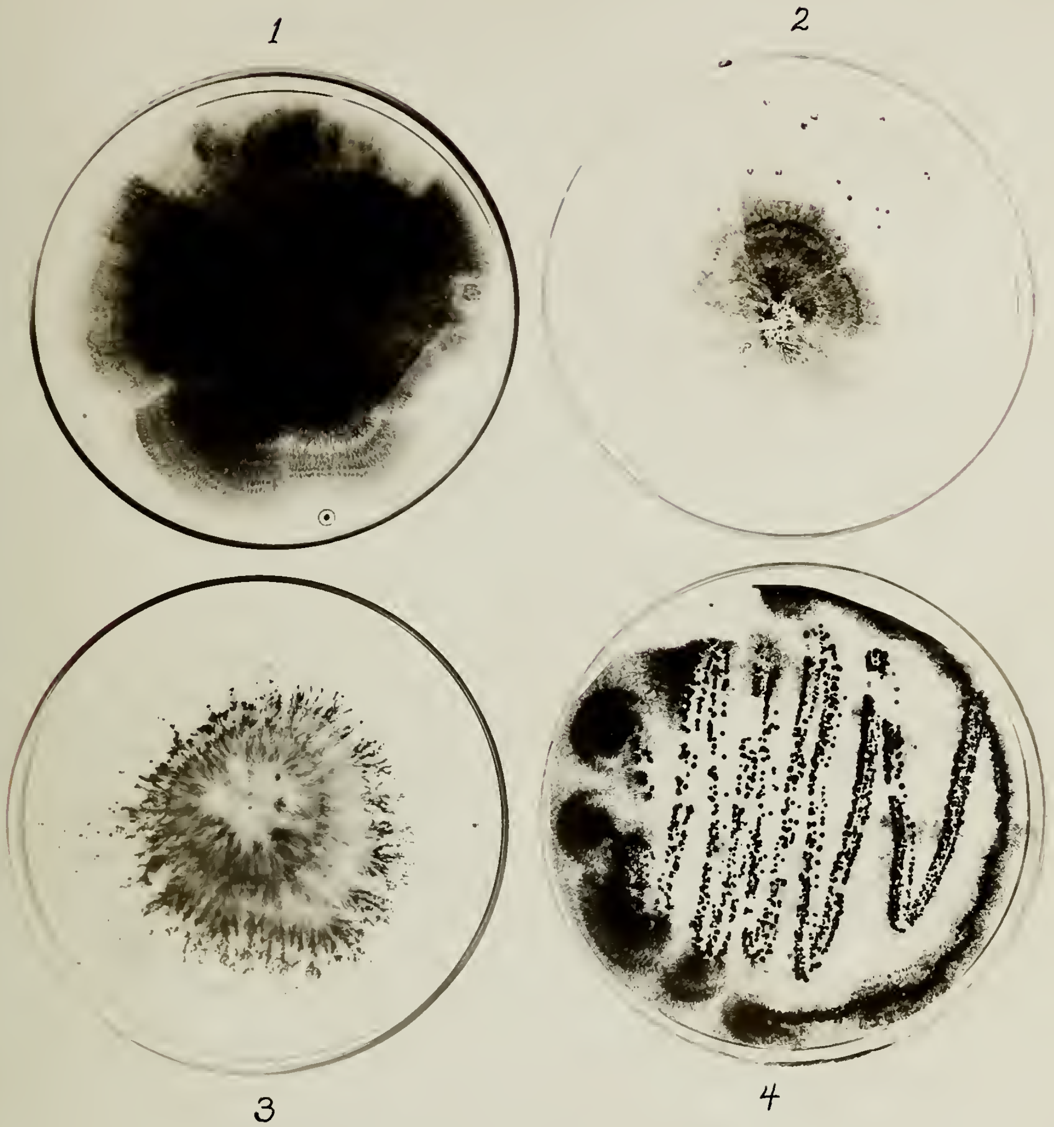


PLATE IV.

THE LIBRARY
OF THE
UNIVERSITY OF ILLINOIS

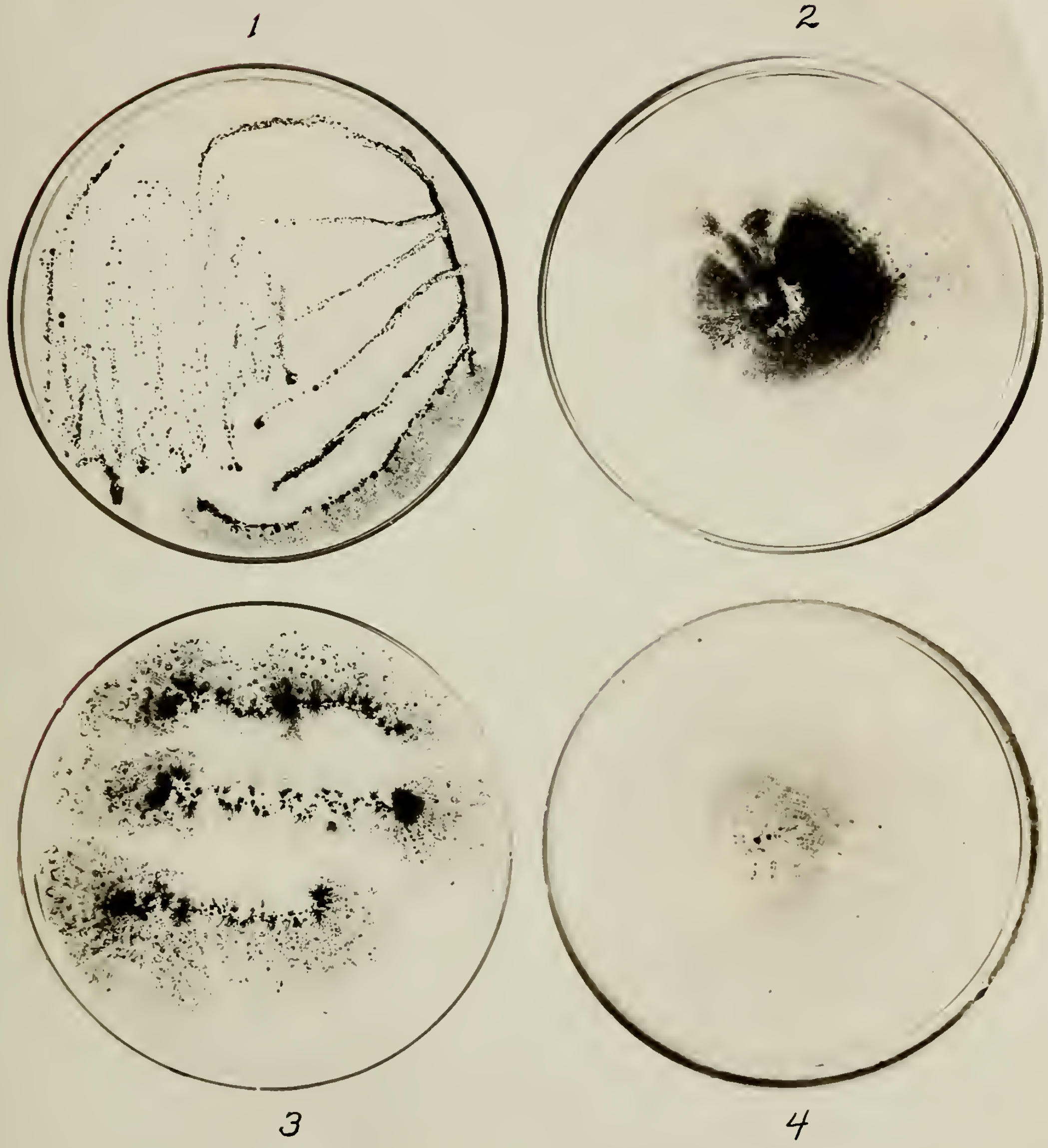


PLATE V.

LIBRARY
OF THE
[illegible]

UNIVERSITY OF ILLINOIS-URBANA
3 0112 086765713